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Patent

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SIR: Transmitted herewith for filing is the **nonprovisional patent application** of

Inventors: Rakesh Bhatia

For: APPARATUS FOR COOLING A HEAT DISSIPATING DEVICE LOCATED WITHIN A PORTABLE COMPUTER

(Title)

Enclosed are:

- X 14 sheets of Drawings.
- X An Assignment of the invention to Intel Corporation.
- X Assignment Cover Sheet Form PTO-1595.
- X A Declaration and Power of Attorney (XXX signed/ _____ unsigned).
- _____ A Verified Statement to establish Small Entity Status under 37 C.F.R. §§ 1.9 and 1.27.

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For:	No. Filed		No. Extra	Rate	Fee	Rate	Fee
Basic Fee:					$ 385		$ 770
Total Claims:	24	- 20	* 4	x 11	$	x 22	$ 88
Indep. Claims:	5	- 3	* 2	x 40	$	x 80	$ 160
	Multiple Dependent Claim(s) Presented			**+130**	**$**	**+260**	**$**
				TOTAL	$	TOTAL	$ 1018

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Respectfully submitted,

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UNITED STATES PATENT APPLICATION

for

APPARATUS FOR COOLING A HEAT DISSIPATING DEVICE LOCATED WITHIN A PORTABLE COMPUTER

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APPARATUS FOR COOLING A HEAT DISSIPATING DEVICE LOCATED WITHIN A PORTABLE COMPUTER

FIELD OF THE INVENTION

The present invention relates to an apparatus for cooling heat dissipating components within electronic and computer system enclosures.

BACKGROUND OF THE INVENTION

Integrated circuits (ICs) are typically housed within a plastic or ceramic package. The packages have leads or surface pads that are soldered to a printed circuit board. The circuit board and package are often located within an enclosed computer chassis that contains other circuitry associated with the computer system such as peripherals, memory cards, video cards, power supplies, etc..

It is desirable to have a high rate of heat transfer from the IC package in order to maintain the temperatures of the IC within safe operating limits. Modern microprocessors typically employ millions of transistors in internal circuitry that require some type of cooling mechanism, otherwise, excessive temperatures may affect the performance of the circuit and cause permanent degradation of the device. Hence, as the performance of integrated circuits continue to expand, the need to provide more efficient, reliable and cost effective heat removal methods has become increasingly important in the design of computer system enclosures and particularly in small general purpose computer systems, such as laptop and notebook computers.

A number of prior art methods have been used to remove heat from heat generating components located within the confines of a computer system enclosure. For example, the method of cooling integrated circuit devices within notebook computers has evolved from the simple attachment of a finned heat sink to the top surface of the device, to the development of finned heat sinks having integral fans. More recent developments have included the use of large, flat heat spreading plates. In such applications, the integrated circuit (generally, the CPU) is directly or indirectly attached to a metal plate having a large heat spreading surface area.

Some prior art heat removal systems utilize the computer keyboard as the system heatsink structure. As shown in Figure 1, a typical computer keyboard 100 includes a support plate 102 onto which is mounted a printed circuit board 104 and a plurality of keys 106 upon which a user may strike to input data into the computer. Generally, the keyboard support plate 102 is configured as one of the largest metallic members within a portable computer and is therefore chosen as a heatsink in some heat removal system designs.

Figure 2 illustrates a prior art heat removal system 200 located within a portable computer. Heat removal system 200 includes a circular heat pipe 110 that transfers heat away from an integrated circuit device 120 to a heat spreading plate 116 that is attached to the keyboard support plate 102. Device 120 is generally attached directly to a copper or aluminum mounting plate 122 by a thermal adhesive. Heat pipe 110 includes an evaporator portion 112 and a condenser portion 114. Evaporator portion 112 is typically embedded in mounting plate 122. Keyboard support plate 102 includes a clamp portion 118 for receiving the condenser portion 114 of heat pipe 110. Heat spreading plate 116 is generally a thin metal plate, such as aluminum.

U.S. Patent No. 5, 568,360 also describes a heat removal system for a portable computer wherein the keyboard support plate serves as the system heat sink.

A common problem associated with these prior art heat removal system is that the heat pipes are attached to a metal heat spreader plate along discrete locations. As a result, the temperature distribution across the surface of the heat spreader plate and keyboard tends to be non-uniform. The thin profile of the heat spreader plate also inhibits a uniform distribution of temperature across the keyboard. These result in the keyboard being substantially warmer in locations adjacent to the heat pipe and cooler at points located away from the heat pipe. This reduces the efficiency of the heat removal system. Moreover, the existence of hot spots along the surface of the keyboard can cause discomfort to the user.

What is needed then is an apparatus and method which solves the aforementioned problems associated with cooling internal electronic circuits located within portable consumer electronic and computer devices. Particularly, what is needed is a highly efficient cooling system that is conformable to the size restrictions imposed by small form factor and thin profile electronic devices, such as, for example, notebook computers.

SUMMARY OF THE INVENTION

An apparatus for removing heat from a heat generating component located within a portable computer system enclosure is disclosed. In accordance with the present invention a flat heat pipe is attached to the bottom surface of a portable computer keyboard support plate. The flat heat pipe is thermally coupled to one or more heat generating components housed within the computer system enclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated by way of example and is not limited by the figures of the accompanying drawings, in which like references indicate similar elements, and in which:

Figure 1 illustrates a perspective view of a prior art computer keyboard.

Figure 2 illustrates a prior art heat removal system.

Figure 3 is a perspective view of a flat heat pipe attached to a keyboard in accordance with one embodiment of the present invention.

Figure 4A is a perspective view of a flat heat pipe in accordance with one embodiment of the present invention.

Figure 4B shows the heat pipe of Figure 4A having a heat generating device thermally coupled to the backside surface of the heat pipe.

Figure 5 is a perspective view of a flat heat pipe in another embodiment of the present invention.

Figure 6 is a bottom of view of a keyboard having a flat heat pipe attached to the backside of the keyboard support plate in one embodiment of the present invention.

Figure 7 is a bottom of view of a keyboard having a flat heat pipe

attached to the backside of the keyboard support plate in another embodiment of the present invention.

Figure 8 illustrates a side-view of a heat removal system in accordance with one embodiment of the present invention.

Figure 9 illustrates a perspective view of a heat removal system in accordance with another embodiment of the present invention.

Figure 10 illustrates a control circuit for a fan assembly in one embodiment of the present invention.

Figure 11 illustrates a perspective view of a heat removal system in another embodiment of the present invention.

Figure 12A illustrates a perspective view of the fan assembly illustrated in Figure 11.

Figure 12B illustrates a top view of the fan assembly illustrated in Figure 12A.

DETAILED DESCRIPTION

An apparatus for removing heat from a heat generating component located within a portable computer system enclosure is disclosed. In the following description, numerous specific details are set forth such as material types, processing steps, etc., in order to provide a thorough understanding of the present invention. However, it will be obvious to one of skill in the art that the invention may be practiced without these specific details. In other instances, well known elements and processing techniques have not been shown in particular detail in order to avoid unnecessarily obscuring the present invention. In order to illustrate the need for cooling systems that are capable of being integrated within an enclosure having limited available space, this discussion will mainly be limited to those needs associated with removing heat from integrated circuits housed within portable computers, such as notebook and laptop computers. It will be recognized, however, that such focus is for descriptive purposes only and that the apparatus and methods of the present invention are applicable to other electronic devices.

Figure 3 illustrates a heat removal apparatus in 200 in one embodiment of the present invention. The heat removal apparatus includes a flat heat pipe 210 that is attached to the metal support plate 206 of a portable computer keyboard 204. Keyboard 204 includes a key pad that is mechanically coupled to a printed circuit board 208. Support plate 206 is generally made of a substantially rigid metal, such as aluminum or steel. The thickness of support plate 206 is typically 0.5 to 1.5 millimeters. In accordance with the present invention, a heat generating device 212 located within a portable computer is thermally coupled to flat heat pipe 210. Flat heat pipe 210 acts to distribute the heat generated by the device in a substantially uniform fashion across the

surface of the keyboard support plate 206. In one embodiment of the invention, heat generated by device 212 is ultimately released from the keypad surface to the ambient environment by natural convection and radiation. The thickness of heat pipe 210 is typically 0.5 to 1.5 millimeters.

As previously noted, traditional heat removal systems have used thin metal heat spreader plates to distribute heat across the surface of the keyboard support plate. Although the use of a thin metal plate has provided sufficient heat spreading capability in the past, the large thermal resistance across the thin cross section of the metal plate inhibits a substantially uniform distribution of heat that is needed for the higher heat generating components of today. The present invention addresses this problem by providing a flat heat pipe 210 along the bottom surface of the keyboard support plate 206. As a result of the flat heat pipe's negligible thermal resistance, heat is more uniformly distributed across the surface of the keyboard support plate 206, thereby increasing the overall thermal efficiency and heat removal capability of the system.

Figure 4A illustrates a perspective view of a flat heat pipe 300 that is used in one embodiment of the present invention. Heat pipe 300 comprises a plurality of micro-channels 302 that are arranged in a parallel configuration. Each of the channels 302 is divided by sidewalls 304 and is sealed to contain a two-phase vaporizable liquid (not shown) which serves as the working fluid for the heat pipe. Each heat pipe draws vaporized fluid away from a heat input point (the evaporator region of the heat pipe) to a condenser region of the heat pipe. Each of heat pipes 302 contains a wick structure (not shown). The wick, by means of capillary flow, transports the condensed liquid from the condenser region back into the evaporator region of the heat pipe. The wick structure may include a wire mesh or grooves along the heat pipe walls, or any other porous

member. Heat pipe 300 generally comprises a thermally conductive and rigid material, such as aluminum or copper. The rigidity of the heat pipe also helps minimize keyboard warpage resulting from user pressure against the keyboard keys.

Turning now to Figure 4B, a heat generating device 330, such as a CPU (central processing unit), is shown attached to the backside surface 308 of heat pipe 300. Arrows 310 and 312 illustrate the working fluid flow pattern in one of micro-channels 302. The portion of the heat pipe residing near device 300 constitutes the evaporator region of the heat pipe. The condenser region resides near the outer side edges of heat pipe 300. Heat vaporizes the working fluid within the evaporator region of the heat pipe and creates a differential pressure between the evaporator region and condenser region. The pressure differential causes the vaporized fluid to be pumped from the evaporator region to the condenser region of the heat pipe. The capillary action of the heat pipe wick causes the condensed working fluid to flow from the condenser region back to the evaporator region.

In one embodiment, heat pipe 300 is made of aluminum. In such an embodiment, a Freon or Freon substitute is used as the heat pipe working medium. Heat pipe 300 may be made of other high thermally conductive materials, such as copper. When heat pipe 300 is made of copper a purified water is generally chosen as the heat pipe working fluid since it is chemically compatible with copper and possesses a high latent heat. The surface area of heat pipe 300 may vary considerably from one design to another. Preferably, the heat pipe surface area is maintained essentially the same as the key pad surface area. In this manner, the key pad surface temperatures will remain substantially isothermal. Among other advantages, this eliminates the

existence of hot spots along the surface of the keyboard making it more comfortable for the user. It is important to note, however, that the keyboard heat pipe of the present invention is not limited to any specific shape or size. In other embodiments, the surface area of the flat heat pipe may be substantially smaller than the key pad surface area and may comprise a variety of other shapes such as circular, polygon, etc..

The internal structure of the keyboard heat pipe of the present invention may vary considerably from one design to another. Thus, it is to be understood that the present inventor is not limited to any one heat pipe configuration. As an example, Figure 5 illustrates a keyboard heat pipe 400 in accordance with another embodiment of the present invention. Heat pipe 400 comprises two thin metal plates, 402 and 404, that are joined by a roll pressing process. Heat pipe 400 is made by first stamping, milling, or otherwise forming one or more heat pipe channels 406 within one, or both, of plates 402 and 404. The heat pipe wicking structure may comprise grooves within the heat pipe channels that are formed during the stamping or milling process. Alternatively, a metal mesh or other porous member may be attached to the channel walls. Once plates 402 and 404 have been joined and sealed, channels 406 are evacuated and then charged with a working fluid.

In Figure 6 a bottom view of a keyboard support plate 502 containing a flat heat pipe 504 is shown. As illustrated, heat pipe 504 covers a significant portion of keyboard support plate 502. An integrated circuit device 506, or any other heat generating device, may be thermally coupled, either directly or indirectly, to heat pipe 504. Since the effective thermal conductivity of heat pipe 504 is very high, there is essentially no limit as to the placement of device 506 on the bottom surface of the heat pipe.

Turning now to Figure 7, a bottom view of a keyboard support plate 512 having a flat heat pipe 514 attached thereto is shown. An advantage of the present invention is that the shape of the flat heat pipe may be augmented in order to accommodate the placement of other components within the housing of a portable computer without greatly affecting the overall heat spreading ability of the apparatus. For example, as shown in Figure 7, the shape of heat pipe 514 includes an open area 518 at one end. In one embodiment, the open area 518 is sized to accommodate the placement of a hard disk drive within a computer housing. It is appreciated that the size, shape, location and number of open areas will vary depending upon the particular space and heat removal requirements of the computer assembly.

With reference to Figure 8, an apparatus for transferring heat from an integrated circuit device 602 to the backside of a keyboard 620 is shown. Keyboard 620 comprises a keypad 626 and a printed circuit board 624 that are attached to a thermally conductive support plate 622. Keyboard support plate 622 is typically made of aluminum. It is appreciated however, that any of a number of other substantially rigid, thermally conductive materials may be used. Integrated circuit device 602 is attached to a C4 package 606 that is housed within a processor module 610. The processor module includes one or more integrated circuit packages that are attached to a printed circuit board 611. A processor module lid 612 that serves to protect the integrated circuit package is attached to printed circuit board 611 by a plurality of fasteners 614. A thermal grease (not shown) is generally disposed between the backside of integrated circuit device 602 and module processor lid 612. A flat heat pipe 628 is thermally coupled to the bottom surface of the metal keyboard support plate 622. Heat pipe 628 may be attached to support plate 622 by any of a variety of

attachment mechanisms such as, thermal adhesives, solder, thermal tape or other known thermal connection techniques, combinations thereof, and/or combinations with known mechanical fasteners such as bolts or the like. Module processor lid 612 is thermally coupled to the bottom surface of heat pipe 628. A thermal grease or other compliant thermally conductive material may be disposed between the bottom surface of heat pipe 628 and the top surface of lid 612 to enhance the heat transfer between the two components. Heat is transferred away from the backside surface of integrated circuit device 602 and into heat pipe 628 across lid 612. Heat pipe 628 distributes the heat generated by the integrated circuit device in a substantially uniform fashion along the backside surface of keyboard support plate 622. The heat is ultimately released from the keypad surface to the ambient environment by natural convection and radiation.

It is important to note that the heat removal system shown in Figure 8 is illustrative of only one of many conceivable heat transfer systems that may be used in conjunction with the present invention. For example, integrated circuit device 602 may be housed within a tape carrier package that is directly attached to the backside of heat pipe 628. Alternatively, device 602 may be located remotely from flat heat pipe 628 and thermally coupled to the flat heat pipe 628 via a low resistant thermal path, such as a traditional round heat pipe.

In the foregoing discussion a passive heat removal apparatus has been described wherein heat is removed from a heat generating device through a flat heat pipe that is attached to the bottom surface of a keyboard support plate. The heat is ultimately released from the keypad surface of the keyboard to the ambient environment by natural convection and radiation. In Figure 9, an alternative embodiment is shown wherein a portion of the heat spreading flat

heat pipe is attached to a fan housing. Figure 9 illustrates a base housing 650 of a notebook computer. A display is usually attached the housing along the backside 601 of the base housing via a hinged connection.

As illustrated, the notebook computer includes a heat generating device 658 that is thermally coupled to the bottom surface of a flat heat pipe 654. The top surface of heat pipe 654 is, in turn, attached to the bottom surface of a computer keyboard support plate 656.

A fan assembly 670 is included within housing 650. Computer housing 650 includes an air inlet 674 located along a first side and an air outlet 676 on a second side (e.g., the back). Fan assembly 670 includes a horizontally mounted fan 672 that is driven by an electric motor 673. Air is drawn into fan housing 671 through air inlet 674. Fan housing 671 includes one or more fins 678 located within an air inlet channel. The fins may be attached to the fan housing or integrally formed therewith. A portion of heat pipe 654 is thermally coupled to fins 678. Heat pipe 654 may be attached directly to fins 678, or alternatively, may be attached to a fan assembly cover plate (not shown) that is thermally coupled to the fins. In one embodiment heat pipe 654 may form a portion of the fan assembly housing cover. As a result of attaching a portion of heat pipe 654 to the fan assembly, a portion of the heat generated by device 658 is dissipated through the flat heat pipe to the fan assembly fins 678. Air flow generated by fan 672 causes air to flow across fins 678. The heated air is then exhausted to the ambient through air outlet 676.

It is important to note that the present invention is not limited to a fan assembly having a set of fins for effecting heat transfer away from heat pipe 654. For example, heat pipe 654 may be attached to a portion of a fan housing that does not included fins. In such an embodiment, an air flow generated by a

fan or other air moving means may be directed so as to impinge a portion of the fan assembly housing that is thermally coupled to heat pipe 654.

Since the effective thermal conductivity of heat pipe 654 is very large, heat generating device 658 can be coupled to heat pipe 654 at essentially any location. Heat generated by device 658 spreads substantially uniformly across the entire heat pipe. In accordance with the heat removal system of Figure 9, a portion of the heat will be dissipated to the ambient through the keyboard via natural convection and radiation. Additionally, a portion of the heat will be removed through the fan assembly fins by means of forced convection heat transfer caused by the air flowing across the fins.

In one embodiment, a control circuit is provided for switching the electric motor 673 of fan assembly 670 on and off. As shown in Figure 10, the control circuit includes a temperature sensing device 680, such as a thermistor, that is attached to the keyboard 656 at one or more locations. Alternatively, temperature sensing device 680 may be attached to heat generating device 658. Temperature sensing device 680 provides an input 682 to a controller, switch, or the like, that controls the delivery of electrical power to fan motor 673. Thus, in order to conserve battery power, fan assembly 670 is energized only during specific operations when additional heat removal capability is required.

Figure 11 illustrates another embodiment of the present invention wherein a portion of the flat heat pipe is thermally coupled to a fan housing. As shown, computer housing 702 includes a heat generating device 708 that is attached to the bottom side of a flat heat pipe 704. The top side of heat pipe 704 is attached to the backside of a keyboard support plate 706. A portion 705 of heat pipe 704 is thermally coupled to fins 728 located within a fan assembly housing 721. The heat removal system of Figure 11 works in essentially the

same manner as the system depicted in Figure 9. The only difference between the two systems lies in the fan assembly configuration.

Fan housing 721 of assembly 720 forms a U-shaped chamber having a closed end portion containing a fan 722 and an open end. An inlet 724 and an outlet 726 are placed at the open end of the housing 721 and are separated by a divider 730. A first set of fins 728a extends from the inlet 724 towards the fan 722, and a second set of fins 728b extends from the fan 722 towards the outlet 726. The air inlet and outlet configuration of fan assembly 721 permits air to enter and exit the fan assembly along one side of the computer housing 702, thus permitting greater flexibility in the design and placement of the computer system components. Figures 12a and 12b illustrate a perspective view and a top view of fan assembly 720 in one embodiment of the present invention, respectively. In one embodiment, fan 722 is offset towards the inlet 724 relative to a longitudinal center line of the housing (i.e., in Figure 12b, a line bisecting the U-shape from top to bottom). Viewed from the top (as shown in Figure 12b), with the inlet 724 on the right, the fan 722 rotates in a counter-clockwise direction. In other embodiments, the fan may be centered, or the inlet and outlet may be switched and the fan rotation reversed.

It is important to note that the embodiments of Figures 9 and 11 are not limited to any specific fan configuration. It is appreciated that any type of air moving means and air moving means housing configuration may be used that permits a portion of a flat heat pipe to be attached to the air moving means housing to effect heat transfer away from the heat pipe.

Thus, a heat removal system has been described that results in a cost efficient, low weight, extremely compact and thermally efficient thermal management system. Although the present invention has been described

particularly with reference to Figures 3 through 12b, it is contemplated that many changes and modifications may be made by one of ordinary skill in the art without departing from the spirit and scope of the present invention.

CLAIMS

What is claimed is:

1. A cooling system in a portable computer for removing heat from a heat generating device, said heat removal system comprising:

a keyboard having a thermally conductive support plate, said support plate having a substantially planar bottom surface; and

a flat heat pipe attached to said bottom surface of said keyboard support plate, said heat generating device thermally coupled to said flat heat pipe.

2. The cooling system of claim 1 wherein said flat heat pipe comprises a plurality of micro-channels that are arranged parallel to one another.

3. The cooling system of claim 1 wherein said flat heat pipe substantially covers said bottom surface of said keyboard support plate.

4. The cooling system of claim 1 wherein said flat heat pipe covers a portion of said bottom surface of said keyboard support plate.

5. The cooling system of claim 1 further comprising air moving means for producing an air flow through an air moving means housing, at least a portion of said housing being thermally coupled to said flat heat pipe.

6. The cooling system of claim 5 wherein said air moving means comprises a fan.

7. The cooling system of claim 1 further comprising a fan for producing an air flow through a fan housing, said fan housing having at least one fin disposed in the path of said air flow, said heat pipe thermally coupled to said fin.

8. The cooling system of claim 5 further comprising a control circuit for switching said fan on or off in response to a temperature measurement on said keyboard.

9. The cooling system of claim 5 further comprising a control circuit for switching said fan on or off in response to a temperature measurement on said heat generating device.

10. The cooling system of claim 5 further comprising:

a temperature sensing device attached to said keyboard; and

a controller for receiving a signal from said temperature sensing device, said controller switching said fan on or off in response to said signal.

11. The cooling system of claim 5 further comprising:

a temperature sensing device attached to said heat generating device; and

a controller for receiving a signal from said temperature sensing device, said controller switching said fan on or off in response to said signal.

12. A heat removal system in a portable computer for removing heat

from a heat generating device, said heat removal system comprising:

a keyboard having a thermally conductive support plate, said support plate having a substantially planar bottom surface;

a flat heat pipe attached to said bottom surface of said keyboard support plate, said heat generating device thermally coupled to said flat heat pipe; and

air moving means for producing an air flow through a housing, at least a portion of said housing being thermally coupled to said flat heat pipe.

13. The heat removal system of claim 12 wherein said flat heat pipe comprises a plurality of micro-channels that are arranged parallel to one another.

14. The heat removal system of claim 12 wherein said air moving means comprises a fan.

15. The heat removal system of claim 12 wherein said air moving means housing includes at least one fin disposed in the path of said air flow, said heat pipe thermally coupled to said fin.

16. The heat removal system of claim 12 further comprising a control circuit for switching said fan on or off in response to a temperature measurement on said keyboard.

17. The heat removal system of claim 12 further comprising a control circuit for switching said fan on or off in response to a temperature measurement of said heat generating device.

18. The heat removal system of claim 12 further comprising:

a temperature sensing device attached to said keyboard; and

a controller for receiving a signal from said temperature sensing device, said controller switching said fan on or off in response to said signal.

19. The heat removal system of claim 12 further comprising:

a temperature sensing device attached to said heat generating device; and

a controller for receiving a signal from said temperature sensing device, said controller switching said fan on or off in response to said signal.

20. A cooling system in a portable computer for removing heat from a heat generating device, said heat removal system comprising:

a keyboard having a thermally conductive support plate, said support plate having a substantially planar bottom surface;

a flat heat pipe attached to said bottom surface of said keyboard support plate, said heat generating device thermally coupled to said flat heat pipe;

a fan for producing an air flow through a fan housing; and

a thermally conductive fin located within said air flow, said heat pipe thermally coupled to said fin.

21. The heat removal system of claim 20 further comprising:

a temperature sensing device attached to said keyboard; and

a controller for receiving a signal from said temperature sensing device, said controller switching said fan on or off in response to said signal.

22. The heat removal system of claim 20 further comprising:

a temperature sensing device attached to said heat generating device; and

a controller for receiving a signal from said temperature sensing device, said controller switching said fan on or off in response to said signal.

23. A cooling system in a portable computer for removing heat from a heat generating device, said heat removal system comprising:

a keyboard having a thermally conductive support plate, said support plate having a substantially planar bottom surface;

a flat heat pipe attached to said bottom surface of said keyboard support plate, said heat generating device thermally coupled to said flat heat pipe;

a fan for producing an air flow through a fan housing;

a thermally conductive fin located within said air flow, said heat pipe thermally coupled to said fin;

a temperature sensing device attached to said keyboard; and

a controller for receiving a signal from said temperature sensing device, said controller switching said fan on or off in response to said signal.

24. A cooling system in a portable computer for removing heat from a heat generating device, said heat removal system comprising:

a keyboard having a thermally conductive support plate, said support plate having a substantially planar bottom surface;

a flat heat pipe attached to said bottom surface of said keyboard support plate, said heat generating device thermally coupled to said flat heat pipe;

a fan for producing an air flow through a fan housing;

a thermally conductive fin located within said air flow, said heat pipe thermally coupled to said fin;

a temperature sensing device attached to said heat generating device; and

a controller for receiving a signal from said temperature sensing device, said controller switching said fan on or off in response to said signal.

ABSTRACT OF THE DISCLOSURE

An apparatus for cooling a heat generating component located within a portable computer system enclosure. In one embodiment a flat heat pipe is attached to the bottom surface of the portable computer keyboard support plate. The flat heat pipe is thermally coupled to one or more heat generating components housed within the computer system enclosure.

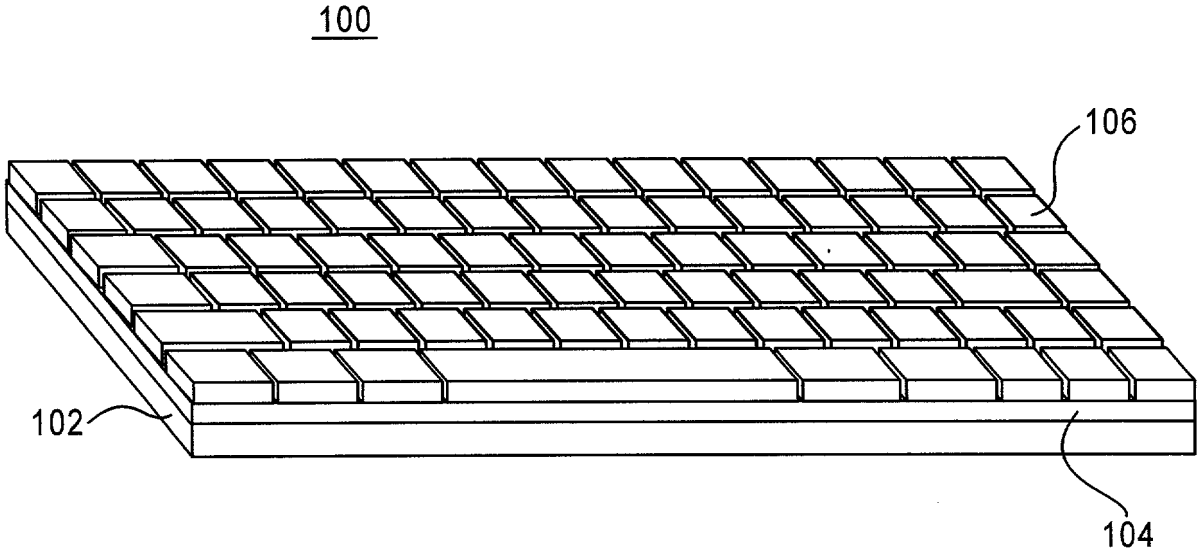

FIG. 1 (PRIOR ART)

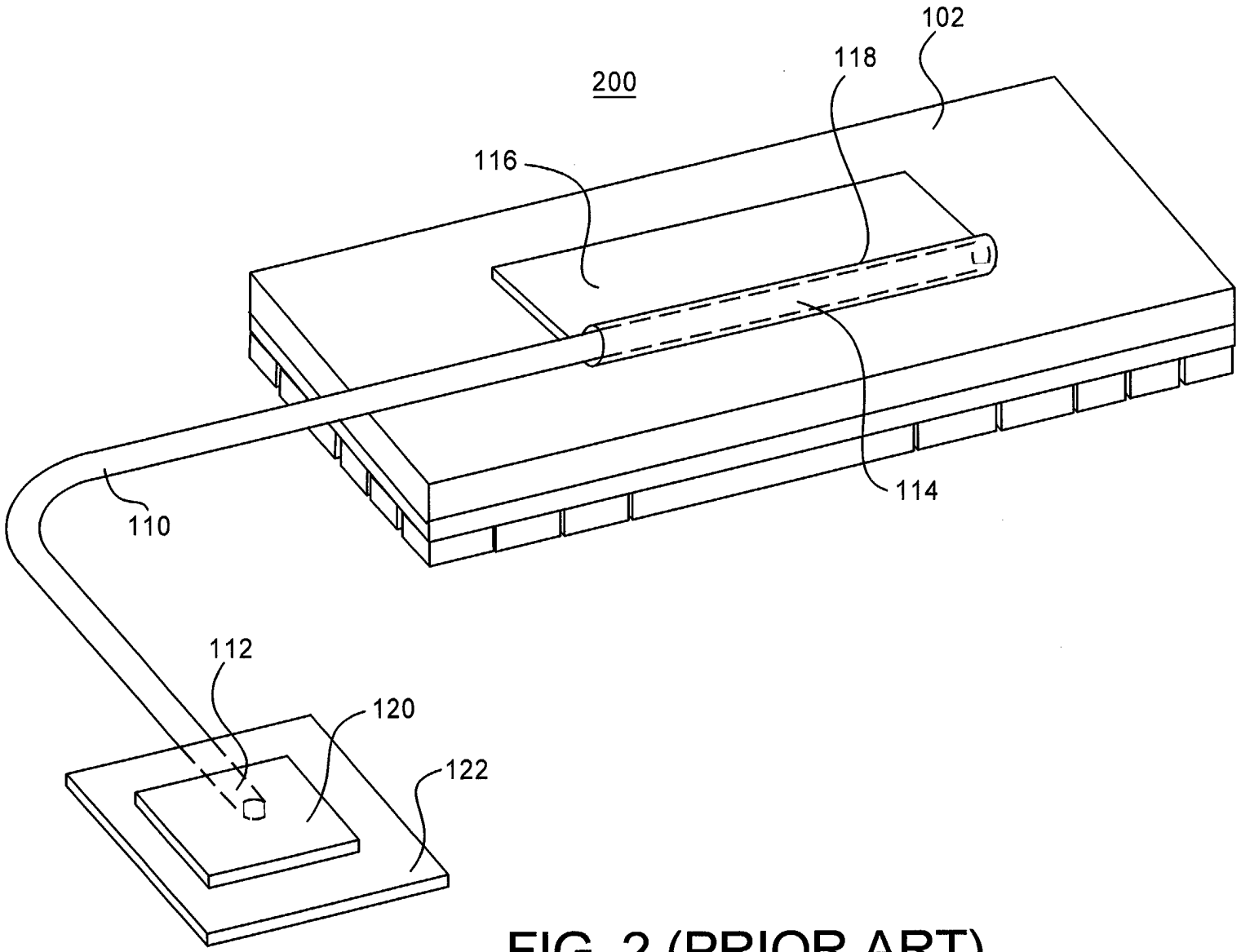

FIG. 2 (PRIOR ART)

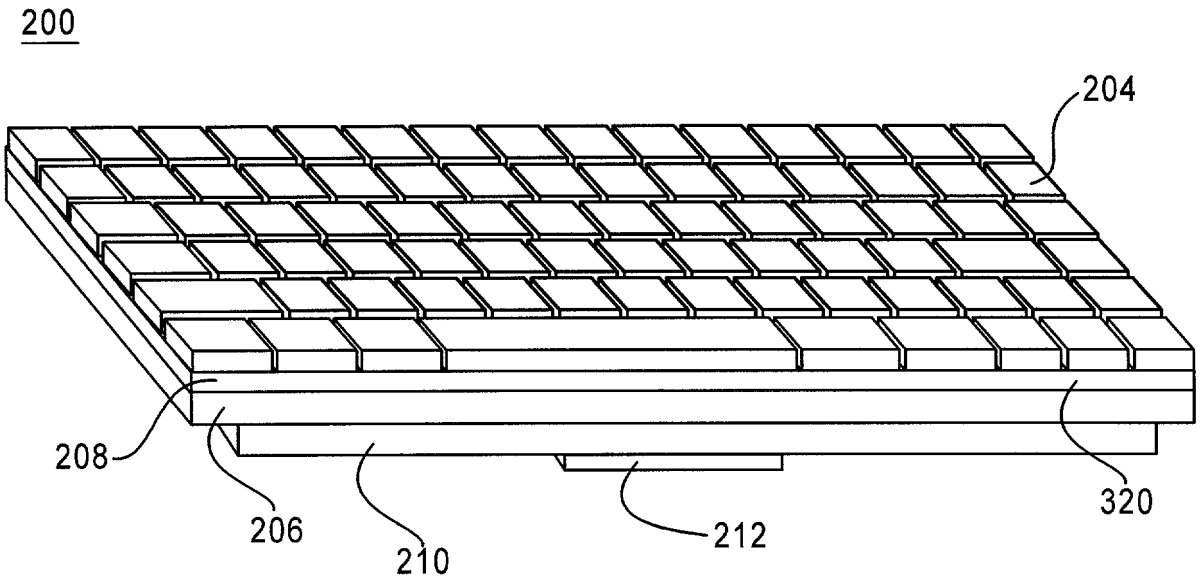

FIG. 3

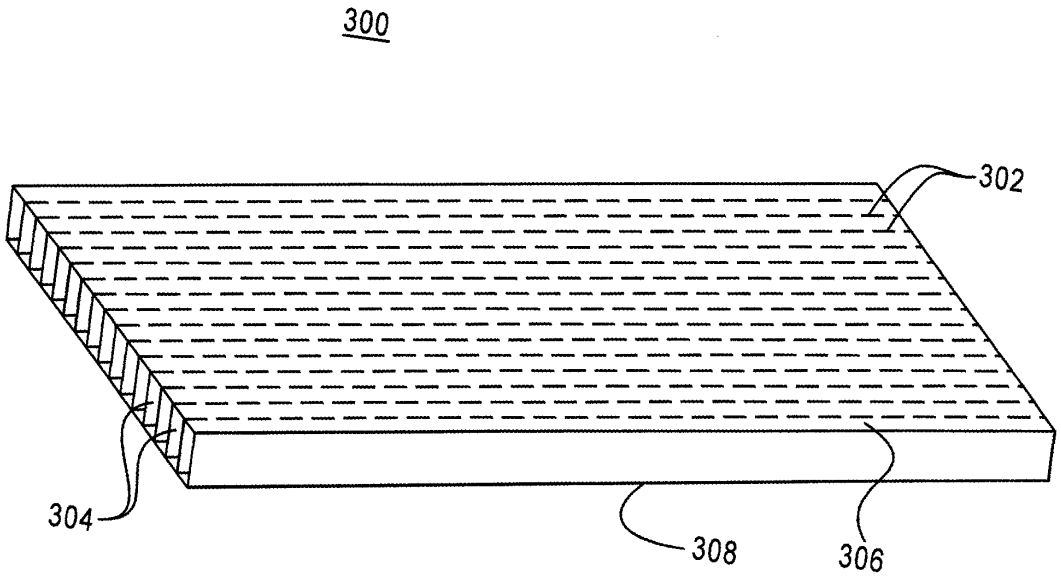

FIG. 4A

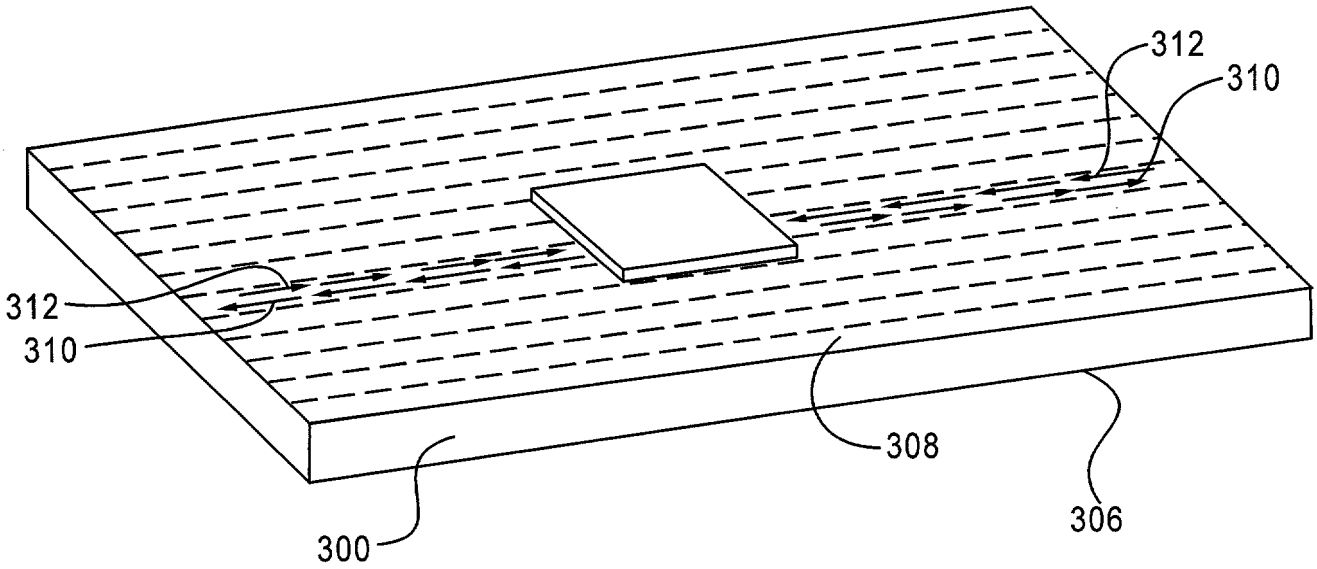

FIG. 4B

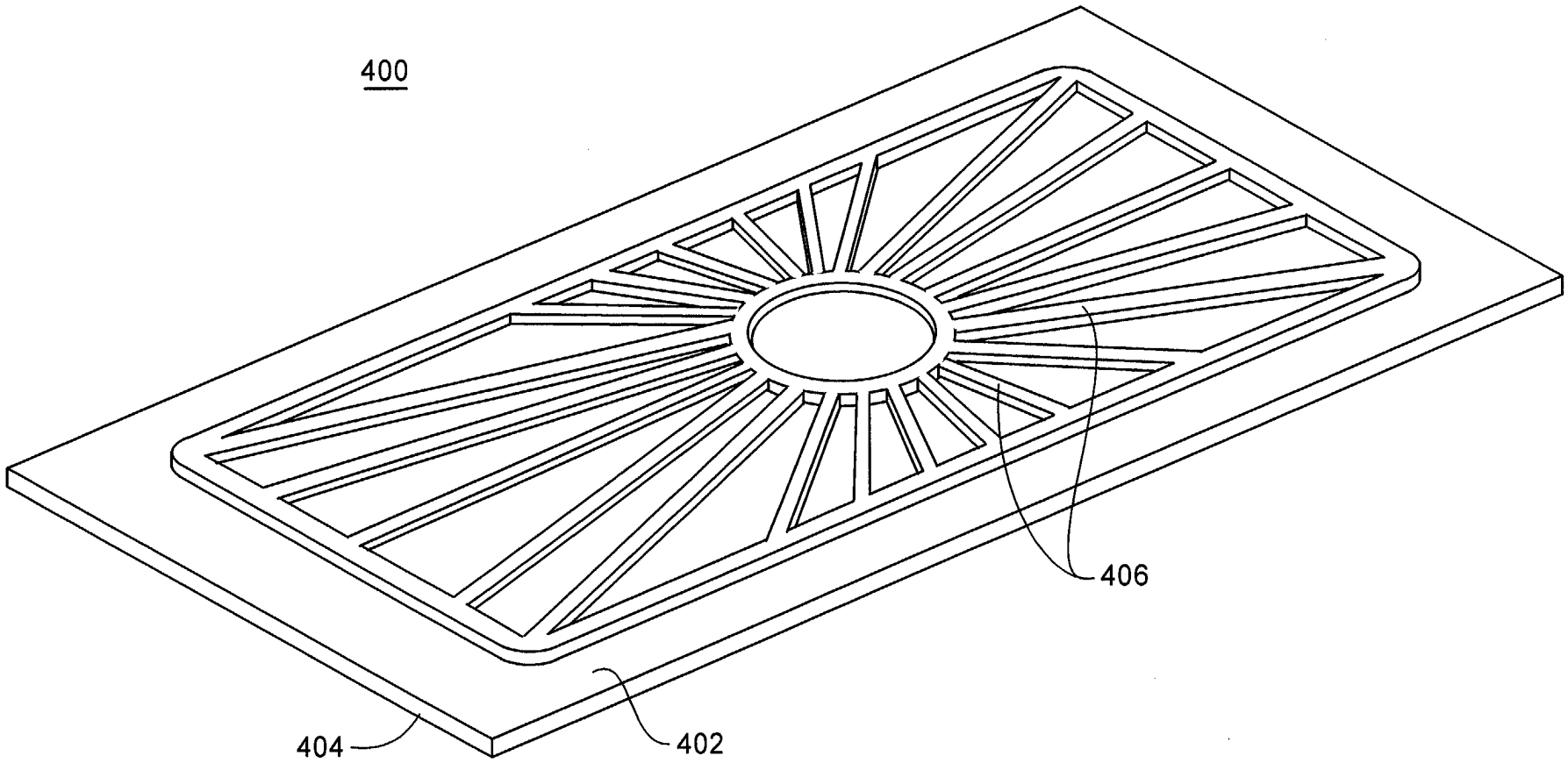

FIG. 5

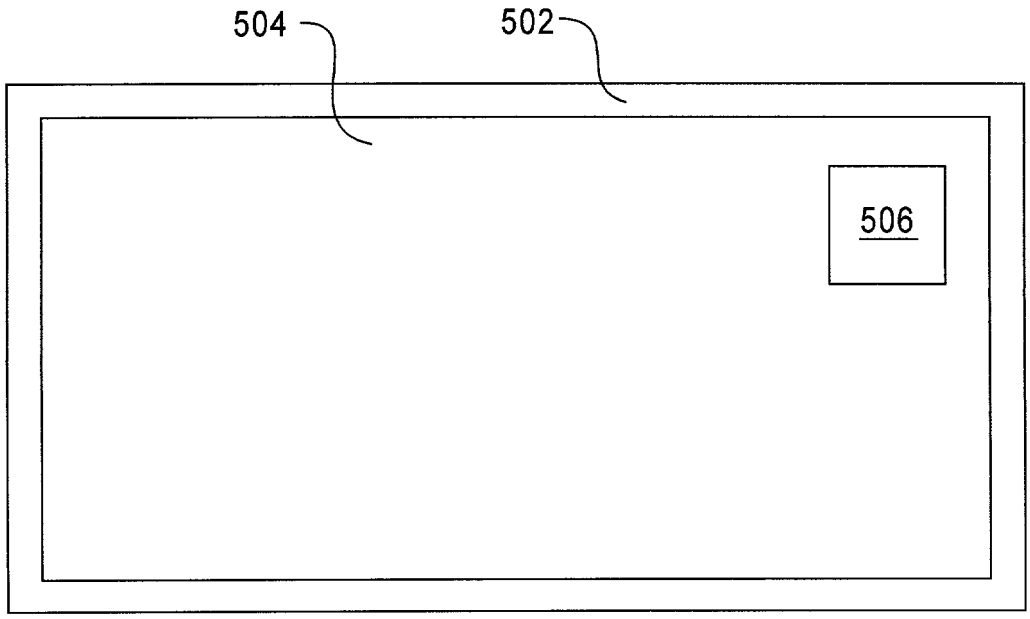

FIG. 6

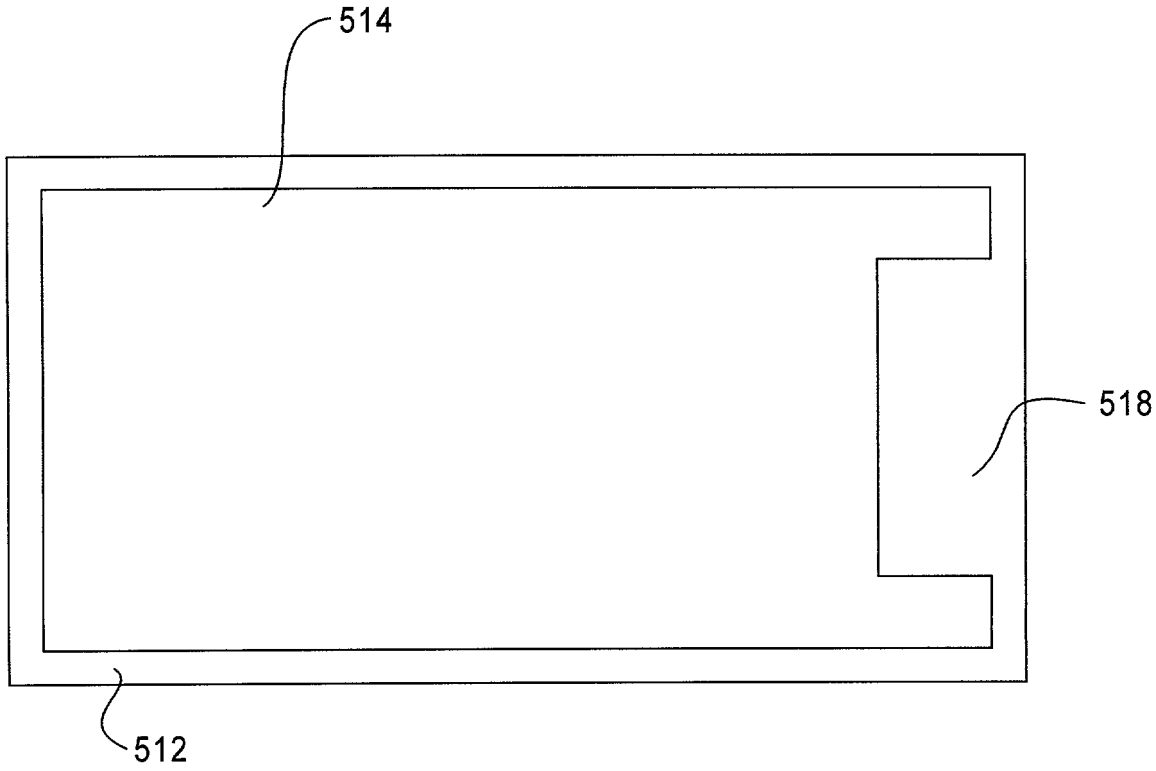

FIG. 7

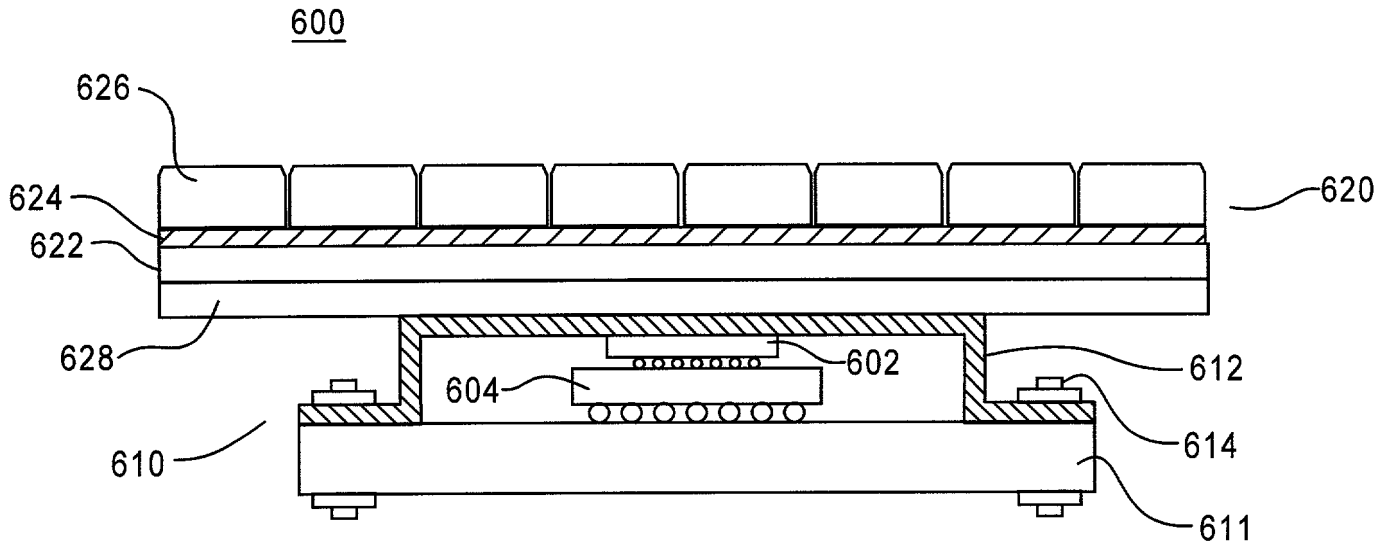

FIG. 8

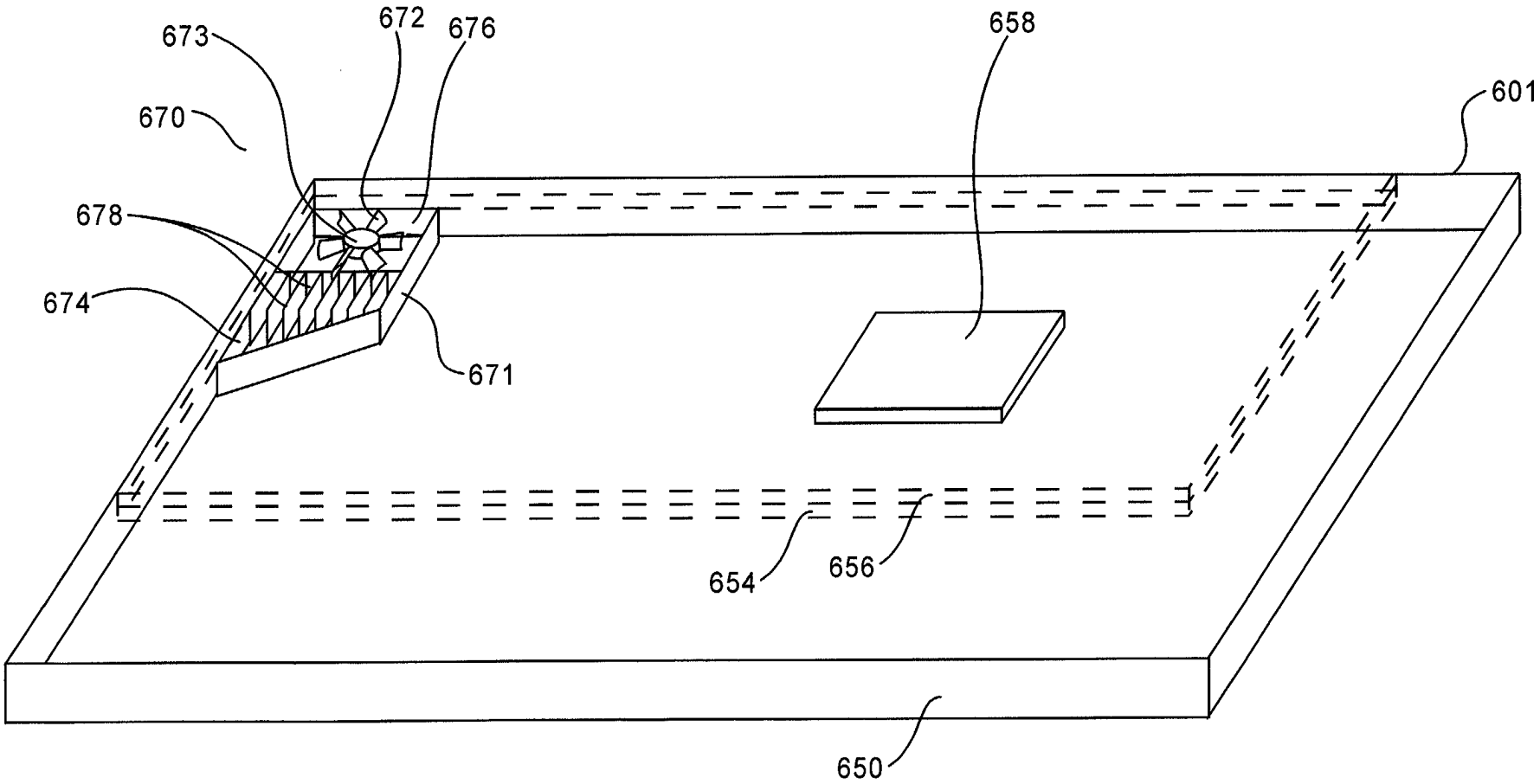

FIG. 9

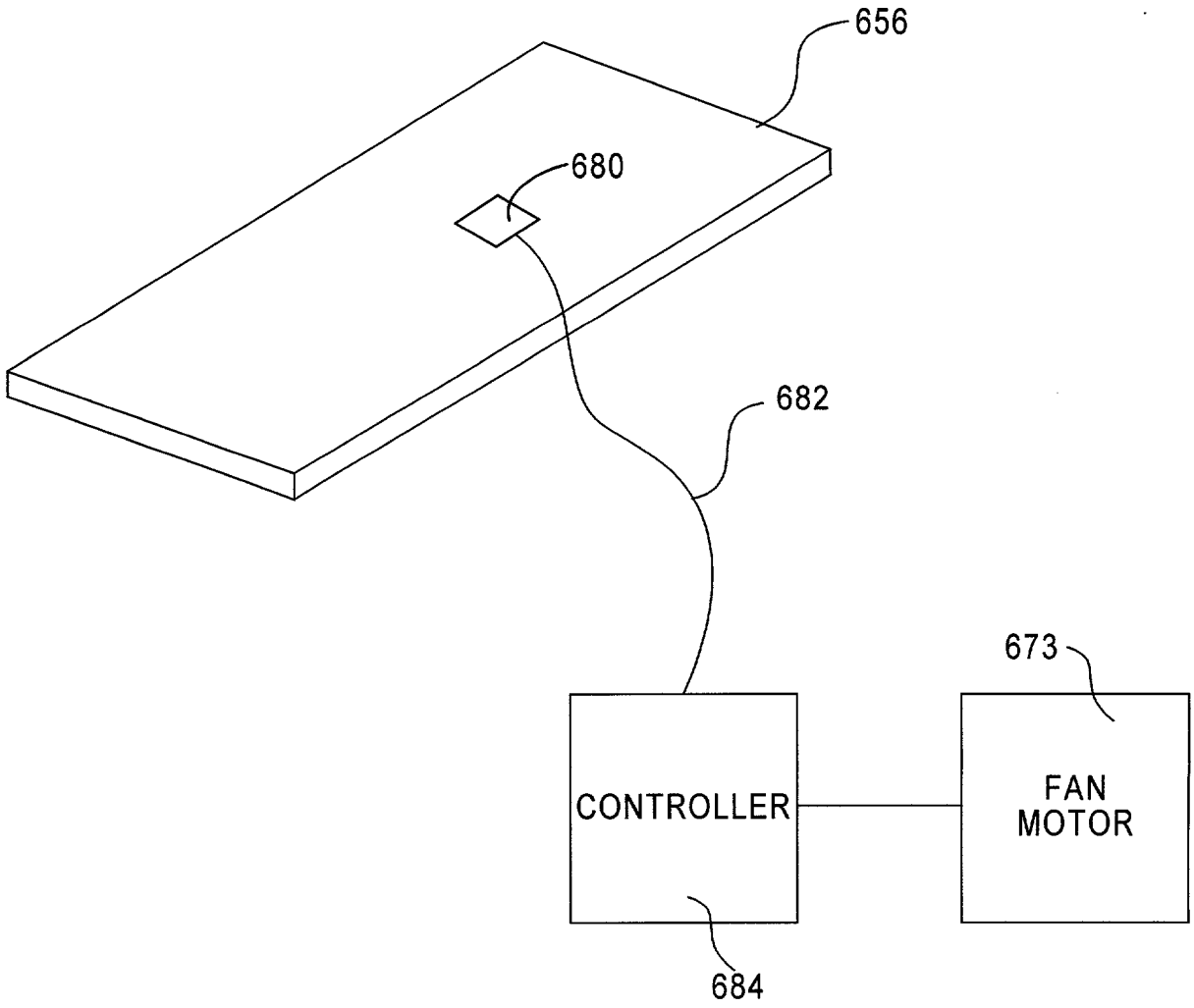

FIG. 10

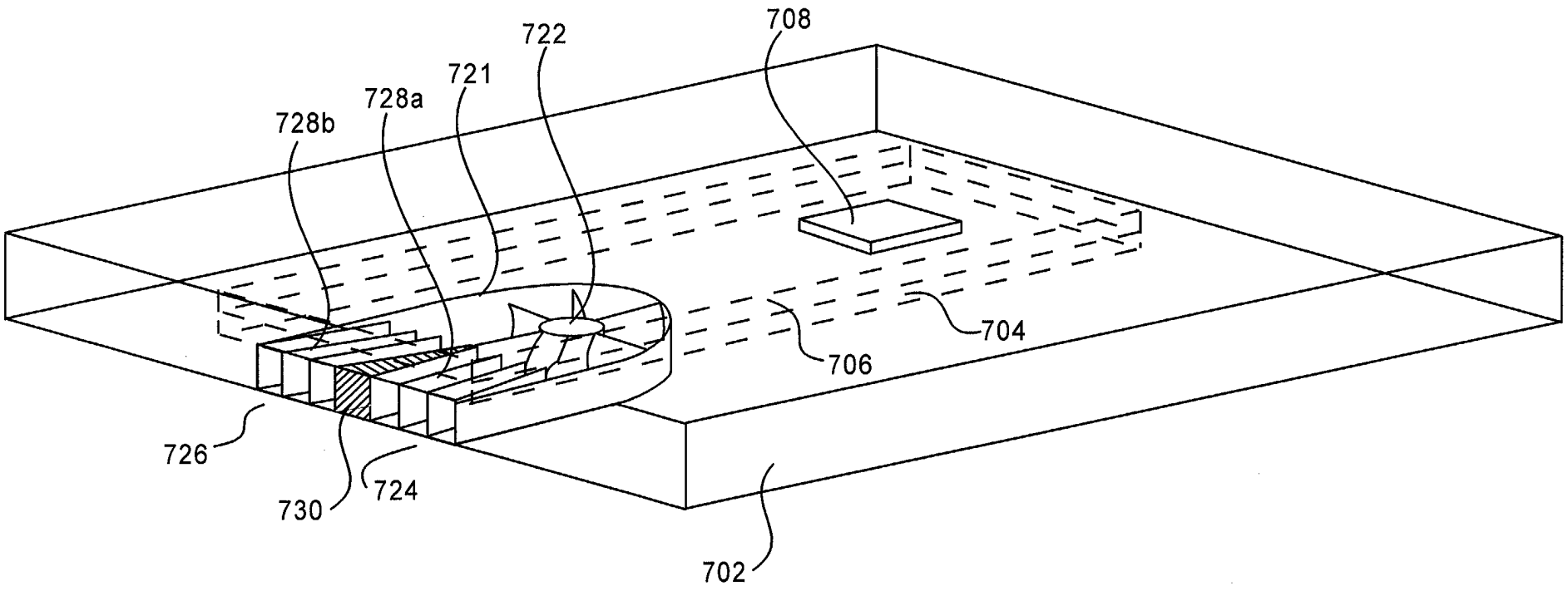

FIG. 11

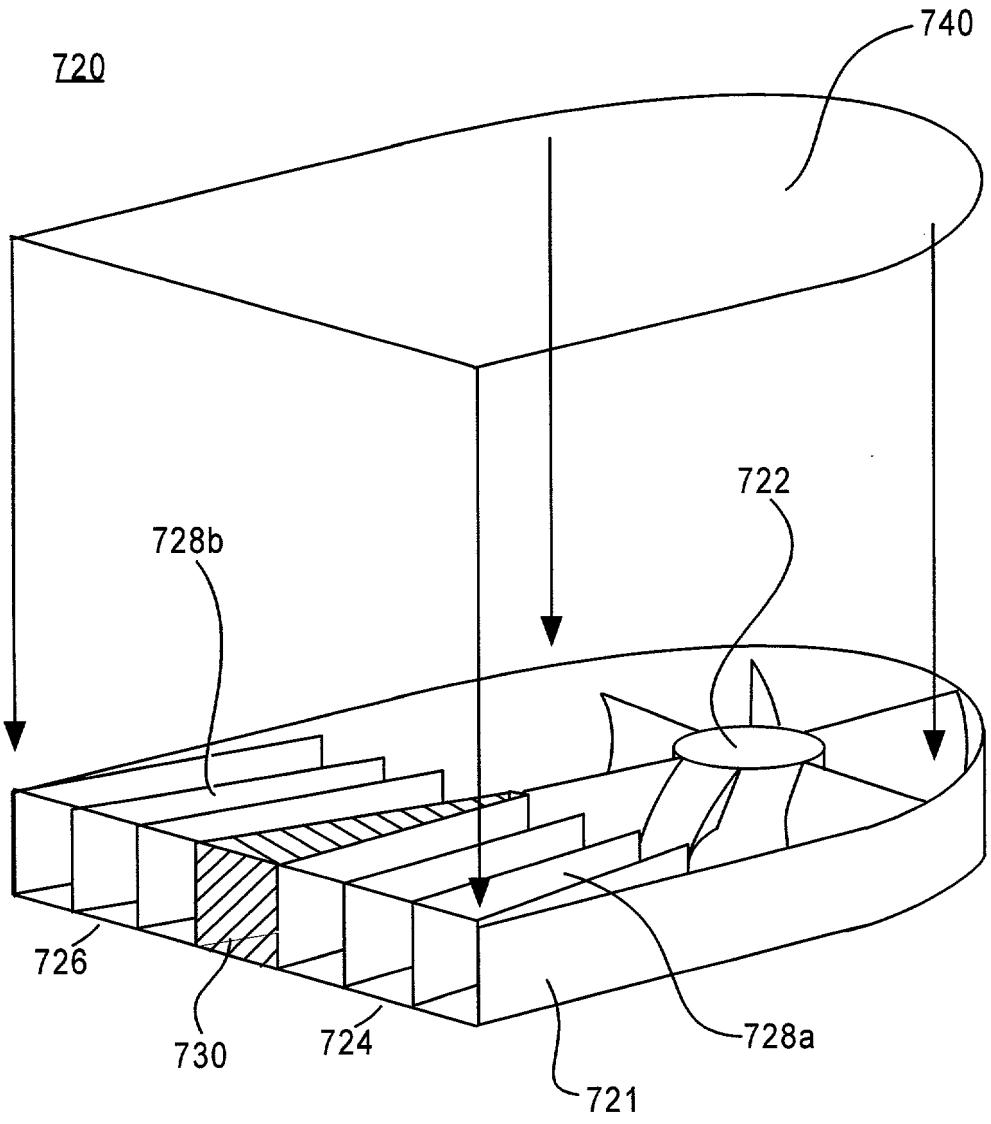

FIG. 12A

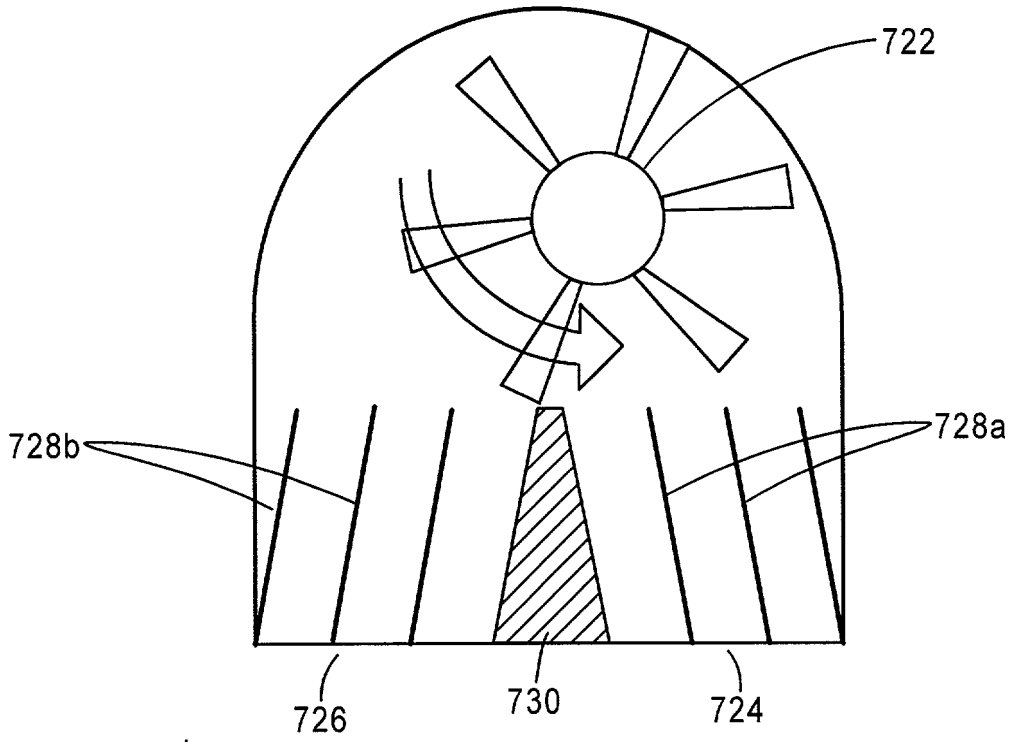

FIG. 12B

Attorney's Docket No.: 42390.P4624 PATENT

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION
(FOR **INTEL CORPORATION** PATENT APPLICATIONS)

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, next to my name.

I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

APPARATUS FOR COOLING A HEAT DISSIPATING DEVICE LOCATED WITHIN A PORTABLE COMPUTER

the specification of which
XXX is attached hereto.
____ was filed on _____as
United States Application Number _____
or PCT International Application Number _____
and was amended on _____
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above. I do not know and do not believe that the claimed invention was ever known or used in the United States of America before my invention thereof, or patented or described in any printed publication in any country before my invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, and that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (for a utility patent application) or six months (for a design patent application) prior to this application.

I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed	
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No

I hereby claim the benefit under title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below

(Application Number)	Filing Date
(Application Number)	Filing Date

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Number)	Filing Date	(Status -- patented, pending, abandoned)
(Application Number)	Filing Date	(Status -- patented, pending, abandoned)

I hereby appoint Aloysius T. C. AuYeung, Reg. No. 35,432; William Thomas Babbitt, Reg. No. 39,591; Jordan Michael Becker, Reg. No. 39,602; Bradley J. Bereznak, Reg. No. 33,474; Michael A. Bernadicou, Reg. No. 35,934; Roger W. Blakely, Jr., Reg. No. 25,831; Gregory D. Caldwell, Reg. No. 39,926; Kent M. Chen, Reg. No. 39,630; Lawrence M. Cho, Reg. No. 39,942; Thomas M. Coester, Reg. No. 39,637; Roland B. Cortes, Reg. No. 39,152; William Donald Davis, Reg. No. 38,428; Daniel M. De Vos, Reg. No. 37,813; Karen L. Feisthamel, Reg. No. 40,264; David R. Halvorson, Reg. No. 33,395; Eric Ho, Reg. No. 39,711; George W Hoover II, Reg. No. 32,992; Eric S. Hyman, Reg. No. 30,139; Dag H. Johansen, Reg. No. 36,172; Stephen L. King, Reg. No. 19,180; Dolly M. Lee, Reg. No. 39,742; Michael J. Mallie, Reg. No. 36,591; Kimberley G. Nobles, Reg. No. 38,255; Ronald W. Reagin, Reg. No. 20,340; James H. Salter, Reg. No. 35,668; William W. Schaal, Reg. No. 39,018; James C. Scheller, Reg. No. 31,195; Maria McCormack Sobrino, Reg. No. 31,639; Stanley W. Sokoloff, Reg. No. 25,128; Allan T. Sponseller, Reg. No. 38,318; Steven R. Sponseller, Reg. No. 39,384; David R. Stevens, Reg. No. 38,626; Edwin H. Taylor, Reg. No. 25,129; Lester J. Vincent, Reg. No. 31,460; John Patrick Ward, Reg. No. 40,216; Ben J. Yorks, Reg. No. 33,609; and Norman Zafman, Reg. No. 26,250; my attorneys; and Gary B. Goates, Reg. No. 35,159; Michael Anthony DeSanctis, Reg. No. 39,957; Charles E. Shemwell, Reg. No. 40,171; Edwin A. Sloane, Reg. No. 34,728; and Judith A. Szepesi, Reg. No. 39,393; my patent agents, of BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP, with offices located at 12400 Wilshire Boulevard, 7th Floor, Los Angeles, California 90025, telephone (310) 207-3800, and Joseph R. Bond, Reg. No. 36,458; Richard C. Calderwood, Reg. No. 35,468; Sean Fitzgerald, Reg. No. 32,027; James E. Jacobson, Jr., Reg. No. 31,626; Naomi Obinata, Reg. No. 39,320; Thomas C. Reynolds, Reg. No. 32,488; Howard A. Skaist, Reg. No. 36,008; and Raymond J. Werner, Reg. No. 34,752; my patent attorneys, of INTEL CORPORATION with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

Send correspondence to Michael A. Bernadicou, BLAKELY, SOKOLOFF, TAYLOR &
(Name of Attorney or Agent)
ZAFMAN LLP, 12400 Wilshire Boulevard, 7th Floor, Los Angeles, California 90025 and direct telephone calls to Michael A. Bernadicou, (408) 720-8598.
(Name of Attorney or Agent)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Sole/First ~~Inventor~~ Rakesh Bhatia

Inventor's Signature *Rakesh Bhatia* Date 07/25/97

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Inventor's Signature ____________________ Date ____________________

Residence ____________________ Citizenship ____________________
(City, State) (Country)

Post Office Address ____________________

Full Name of Third/Joint Inventor ____________________

Inventor's Signature ____________________ Date ____________________

Residence ____________________ Citizenship ____________________
(City, State) (Country)

Post Office Address ____________________

Full Name of Fourth/Joint Inventor ____________________

Inventor's Signature ____________________ Date ____________________

Residence ____________________ Citizenship ____________________
(City, State) (Country)

Post Office Address ____________________

Title 37, Code of Federal Regulations, Section 1.56
Duty to Disclose Information Material to Patentability

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclosure information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclosure all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) Prior art cited in search reports of a foreign patent office in a counterpart application, and

(2) The closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made or record in the application, and

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or

(2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office, or

(ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

(1) Each inventor named in the application;

(2) Each attorney or agent who prepares or prosecutes the application; and

(3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.